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[Title of the Invention]      METHOD FOR MANUFACTURING LIQUID  
CRYSTAL DISPLAY DEVICE

## [Abstract]

[Object] To realize a method for manufacturing liquid crystal display device capable of removing a positional deviation at the time of mutually sticking upper and lower substrates and removing defects such as uneven images.

[Solving Means] A lower substrate 3 whose upper surface is coated with an adhesive 1 and to which a liquid crystal (LC) material 2 is dropped is arranged in a vacuum container C, the whole lower surface is fixed by vacuum suction using a suction mechanism 5, an upper substrate 12 is arranged so as to be opposed to the lower substrate 3 at a prescribed interval, and the whole upper surface is fixed by vacuum suction using a suction mechanism 7. Then both the substrates 3 and 6 or either one of them are approached so as to bring the upper substrate 12 into contact with the liquid crystal material 2 or the adhesive 1 and both the substrates 3 and 6 are relatively moved in a substrate surface direction to align them. Then both the substrates 3 and 6 or either one of them are approached to each other and mutually pressurized to stick both the substrates 3 and 6 to each other.

## [Claims]

[Claim 1] A method for manufacturing a liquid crystal display device the steps of arranging a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped in a vacuum container and fixing the whole lower surface of the lower substrate with vacuum suction, arranging an upper substrate so as to be opposite to the lower substrate at a prescribed interval and fixing the whole upper surface of the upper substrate with vacuum suction, approaching both or either one of the substrates to each other so as to bring the upper substrate into contact with the liquid crystal material or the adhesive, relatively moving both the substrates in a substrate surface direction to align the substrates, approaching both or either one of the substrates to each other to pressurize both the substrates to each other, and sticking both the substrates to each other.

[Claim 2] A method for manufacturing a liquid crystal display device the steps of arranging a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped in a vacuum container and fixing the whole lower surface of the lower substrate with vacuum suction, arranging an upper substrate so as to be opposite to the lower substrate at a prescribed interval and fixing the whole upper surface of the upper substrate

with vacuum suction, approaching both or either one of the substrates to each other at a prescribed interval location, relatively moving both the substrates in a substrate surface direction to perform pre-alignment, approaching both or either one of the substrates so as to bring the upper substrate into contact with the liquid crystal material or the adhesive, relatively moving both the substrates in a substrate surface direction to align the substrates, approaching both or either one of the substrates to each other to pressurize both the substrates to each other, and sticking both the substrates to each other.

[Claim 3] The method according to Claim 1 or 2, wherein the upper substrate is held at a location having a micro-gap with the adhesive when bringing the upper substrate into contact with the liquid crystal material or the adhesive.

[Claim 4] The method according to Claim 1 or 2, wherein an elastic body is interposed between the lower substrate and a vacuum suction mechanism.

[Claim 5] The method according to Claim 1 or 2, wherein, the suction of the lower substrate is released after the lower substrate and the upper substrate are stuck to each other.

[Claim 6] The method according to Claim 1 or 2, wherein the suction of the lower substrate is released after the lower substrate and the upper substrate are stuck to each

other, and the lower substrate and the upper substrate are temporarily fixed to each other by an ultraviolet ray curing type adhesive after the pressure of the vacuum container is returned to the atmospheric pressure.

[Claim 7] The method according to Claim 1 or 2, wherein the suction of the lower substrate is released and the pressure of the vacuum container is returned to the atmospheric pressure after the lower substrate and the upper substrate are stuck to each other and temporarily fixed to each other by an ultraviolet ray curing type adhesive.

[Claim 8] The method according to Claim 1 or 2, wherein the location of at least one of the upper substrate and the lower substrate is controlled by a controlling mechanism.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a method for manufacturing a liquid crystal display device used as an image display panel such as a personal computer or a television.

[0002]

[Description of the Related Art]

A conventional method for manufacturing a liquid crystal display device will be described with reference to Figs. 5 to 8.

[0003]

In the structure of the liquid crystal display device, as shown in Fig. 5, a regular gap is held between a lower substrate 11 and an upper substrate 12 which are opposite to each other and consist of light-penetrating material, a liquid crystal material 8 is filled in the gap, and both the substrates 11 and 12 are stuck to each other by an ultraviolet ray curing type adhesive 13. The adhesive 13 contains spacers 12 for holding regular interval (for example, a diameter of 5  $\mu\text{m}$ ) between the upper substrate 12 and the lower substrate 11.

[0004]

As a method for arranging a liquid crystal material 15 in the adhesive 13, as shown in Fig. 6, there is a liquid crystal dropping method including coating the adhesive 13 on the lower substrate 11 with a predetermined thickness (for example, 30  $\mu\text{m}$ ) (process a), dropping the liquid crystal material 15 in the adhesive 13 (process b), superposing the upper substrate 12 on the lower substrate 11 and pressurizing both the substrates 11 and 12 until the interval between the upper substrate 12 and the lower substrate 11 becomes a predetermined value (for example, 5  $\mu\text{m}$ ) (process c), and irradiating ultraviolet rays 16 to the adhesive 13 to harden the adhesive 13 (process d) to complete a liquid crystal display device.

[0005]

Hereinafter, a method for sticking two substrates will be described in detail with reference to Figs. 7 and 8.

[0006]

First, the lower substrate 11 whose upper surface is coated with an ultraviolet ray curing type adhesive 13 with a thickness of 30  $\mu\text{m}$  and to which a liquid crystal material 15 is arranged in the adhesive 13 is mounted on a table 17 which can be horizontally moved, and the whole lower surface thereof is fixed by a vacuum suction force of a suction mechanism 18 (process a). Next, the upper substrate 12 is arranged so as to be opposite to the lower substrate 11 at a prescribed interval and the whole upper surface thereof is fixed by a vacuum suction force of a suction mechanism 19 (process b). Next, the upper substrate 12 is lowered so that the interval between the upper substrate 12 and the lower substrate 11 becomes 1 mm, and a vacuum container C is closed (process c). Next, the table 17 having the lower substrate 11 mounted thereon is moved in a horizontal direction, the lower substrate 11 and the upper substrate 12 are aligned and the vacuum container C is evacuated (process d). Next, the upper substrate 12 is lowered to be brought into contact with the liquid crystal material 15 or the adhesive 13, is pressurized until the interval between the lower substrate 11 and the upper substrate 12 becomes 5  $\mu\text{m}$ ,

and is stuck to the lower substrate 11 through the adhesive 13 (process e). Thereafter, ultraviolet rays 16 are irradiated to the adhesive 13 to harden the adhesive 13 (process f), and thus the sticking operation of the lower substrate 11 and the upper substrate 12 is completed.

[0007]

[Problems to be Solved by the Invention]

However, in the conventional method, the upper substrate 12 and the lower substrate 11 are aligned so that the interval therebetween becomes 1 mm and then the upper substrate 12 is lowered by 1 mm to be brought into contact with the liquid crystal material 15 and the adhesive 13 and is pressurized in the vertical direction so that both the substrates are stuck to each other. Accordingly, the positional deviation is generated in the lowering and pressurizing operations.

[0008]

An object of the present invention is to provide a method for manufacturing a liquid crystal display device which can remove positional deviation when mutually sticking the lower substrate and the upper substrate and remove defect such as uneven images.

[0009]

[Means for Solving the Problems]

According to the present invention, there is provided a method for manufacturing a liquid crystal display device the steps of arranging a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped in a vacuum container and fixing the whole lower surface of the lower substrate with vacuum suction, arranging an upper substrate so as to be opposite to the lower substrate at a prescribed interval and fixing the whole upper surface of the upper substrate with vacuum suction, approaching both or either one of the substrates to each other so as to bring the upper substrate into contact with the liquid crystal material or the adhesive, relatively moving both the substrates in a substrate surface direction to align the substrates, approaching both or either one of the substrates to each other to pressurize both the substrates to each other, and sticking both the substrates to each other. Since the alignment is performed after bringing the upper substrate into contact with the liquid crystal material and the adhesive, the state change due to the movement after the alignment is reduced and the moved distance is short. Thus, the positional deviation at the time of sticking the lower substrate and the upper substrate can be removed and thus defect such as uneven image can be removed.

[0010]

According to the present invention, there is also provided a method for manufacturing a liquid crystal display device the steps of arranging a lower substrate whose upper surface is coated with an adhesive and to which a liquid crystal material is dropped in a vacuum container and fixing the whole lower surface of the lower substrate with vacuum suction, arranging an upper substrate so as to be opposite to the lower substrate at a prescribed interval and fixing the whole upper surface of the upper substrate with vacuum suction, approaching both or either one of the substrates to each other at a prescribed interval location, relatively moving both the substrates in a substrate surface direction to perform pre-alignment, approaching both or either one of the substrates so as to bring the upper substrate into contact with the liquid crystal material or the adhesive, relatively moving both the substrates in a substrate surface direction to align the substrates, approaching both or either one of the substrates to each other to pressurize both the substrates to each other, and sticking both the substrates to each other. Thereby, the positional deviation at the time of sticking the lower substrate and the upper substrate can be removed and thus defect such as uneven image can be removed. Also, the movement amount of the lower substrate is reduced by the pre-alignment when performing the alignment and thus the adhesive is more

suppressed from being melted into the liquid crystal material.

[0011]

Also, since the upper substrate is held at a location having a micro-gap with the adhesive when bringing the upper substrate into contact with the liquid crystal material or the adhesive, the upper substrate and the lower substrate can be prevented from being tightly fixed to each other. Thus, a problem that the alignment can not be performed can be removed.

[0012]

Further, since the elastic body is interposed between the lower substrate and the suction mechanism, the gap between the upper substrate and the lower substrate can be obtained with high precision. Also, in this case, if the suction of the lower substrate is released after sticking the lower substrate and the upper substrate to each other, both the substrates are fixed by the suction mechanism of the upper substrate. Thus, the plane degree of both the substrates can be obtained with high precision.

[0013]

Moreover, since the suction of the lower substrate is released after the lower substrate and the upper substrate are stuck to each other, and the lower substrate and the upper substrate are temporarily fixed to each other by an

ultraviolet ray curing type adhesive after the pressure of the vacuum container is returned to the atmospheric pressure, the positional deviation of the upper substrate and the lower substrate can be surely prevented.

[0014]

Moreover, since the suction of the lower substrate is released and the pressure of the vacuum container is returned to the atmospheric pressure after the lower substrate and the upper substrate are stuck to each other and temporarily fixed to each other by an ultraviolet ray curing type adhesive, the positional deviation of the upper substrate and the lower substrate can be surely prevented.

[0015]

Also, since the location of at least one of the upper substrate and the lower substrate is controlled by the controlling mechanism, the upper substrate or the lower substrate can be surely fixed.

[0016]

[Description of the Embodiments]

Hereinafter, a method for manufacturing a liquid crystal display device according to a first embodiment of the present invention will be described with reference to Figs. 1 and 2.

[0017]

First, a lower substrate 3 whose upper surface is

coated with an ultraviolet ray curing type adhesive 1 with a thickness of 30  $\mu\text{m}$  and to which a liquid crystal material 2 is arranged in the adhesive 1 is mounted on a table 4 which can be horizontally moved, and the whole lower surface of the lower substrate 3 is fixed by a vacuum suction force of a suction mechanism 5 (process a). Here, the lower substrate 3 consists of light-penetrating material.

[0018]

Next, the upper surface of a upper substrate 6 consisting of light-penetration material is fixed by a vacuum suction force of a suction mechanism 7, and a vacuum container C is closed and evacuated. Then, the suction mechanism 7 is lowered in the vertical direction to bring the upper substrate 6 into contact with the liquid crystal material 2 or the adhesive 1 (process b). Next, the table 4 having the lower substrate 3 mounted thereon is moved in a horizontal direction, the lower substrate 3 and the upper substrate 6 are aligned (process c)

[0019].

Next, the suction mechanism 7 is lowered in the vertical direction and the upper substrate 6 is pressurized so that the interval between the lower and upper substrates becomes 5  $\mu\text{m}$  and is stuck to the lower substrate 3 through the adhesive 1 (process d). Thereafter, the substrates which are stuck to each other are carried out of the vacuum

container C and ultraviolet rays 8 are irradiated to harden to adhesive 1 (process e). Thus, the operation of sticking the lower substrate 3 and the upper substrate 6 is completed.

[0020]

According to this method, the alignment precision of the two substrates 3 and 6 which are opposite to each other can be suppressed to 1  $\mu\text{m}$  or less and thus uneven images can be removed.

[0021]

Also, the thickness until the substrate is pressurized in the process d may be changed according to a diameter of spacers contained in the adhesive 1.

[0022]

Next, a method for manufacturing a liquid crystal display device according to a second embodiment of the present invention will be described with reference to Figs. 3 and 4.

[0023]

First, a lower substrate 3 whose upper surface is coated with an ultraviolet ray curing type adhesive 1 with a thickness of 30  $\mu\text{m}$  and to which a liquid crystal material 2 is arranged in the adhesive 1 is mounted on a table 4 which can be horizontally moved, and the whole lower surface of the lower substrate 3 is fixed by a vacuum suction force of a suction mechanism 5 (process a). Here, the lower

substrate 3 consists of light-penetrating material.

[0024]

Next, the upper surface of a upper substrate 6 consisting of light-penetration material is fixed by a vacuum suction force of a suction mechanism 7, and a vacuum container C is closed and evacuated. Then, the upper substrate 6 is lowered so that the interval between the lower substrate 3 and the upper substrate 6 becomes 1 mm, and the table 4 having the lower substrate 3 mounted thereon is moved in the horizontal direction so that pre-alignment of the lower substrate 3 and the upper substrate 6 is performed (process b). Next, the suction mechanism 7 is lowered in the vertical direction to bring the upper substrate 6 into contact with the liquid crystal material 2 or the adhesive 1 (process c). Next, the table 4 having the lower substrate 3 mounted thereon is moved in a horizontal direction, the lower substrate 3 and the upper substrate 6 are aligned (process d)

[0025].

Next, the suction mechanism 7 is lowered in the vertical direction and the upper substrate 6 is pressurized so that the interval between the lower and upper substrates becomes 5  $\mu\text{m}$  and is stuck to the lower substrate 3 through the adhesive 1 (process e). Thereafter, the substrates which are stuck to each other are carried out of the vacuum

container C and ultraviolet rays 8 are irradiated to harden to adhesive 1 (process f). Thus, the operation of sticking the lower substrate 3 and the upper substrate 6 is completed.

[0026]

According to this method, the alignment precision of the two substrates 3 and 6 which are opposite to each other can be suppressed to 1  $\mu\text{m}$  or less and thus uneven images can be removed. Particularly, since the pre-alignment is performed, the movement amount of the lower substrate 3 is reduced when performing the alignment and thus the adhesive 1 is more suppressed from being melted into the liquid crystal material 2 according to the movement of the substrate.

[0027]

Also, the thickness until the substrate is pressurized in the process e may be changed according to a diameter of spacers contained in the adhesive 1.

[0028]

Further, in order to prevent the lower substrate 3 and the upper substrate 6 from being tightly fixed to each other by the adhesive 1 so that the alignment can not be performed, a mechanism for holding the gap between the upper substrate 6 and the lower substrate 3 to 100  $\mu\text{m}$  from the height of the adhesive 1 may be further included so that the upper substrate 6 is brought into contact with only the liquid

crystal material 2 in the process c.

[0029]

In order to obtain the gap between the upper substrate 6 and the lower substrate 3 with high precision, an elastic body may be interposed between the lower substrate 3 and the suction mechanism 5. In case of having the elastic body, in order to obtain the plane degree of the stuck upper and lower substrates 6 and 5 with high precision, it is preferable that, after the lower substrate 3 and the upper substrate 6 are stuck to each other, the suction of the lower substrate 3 is released and the lower substrate 3 and the upper substrate 6 are fixed by the suction of the suction mechanism 7.

[0030]

Moreover, in order to prevent the deviation of the upper substrate 6 and the lower substrate 5 after the sticking operation, the suction of the lower substrate 3 may be released after sticking the lower substrate 3 and the upper substrate 6 to each other, and the upper substrate 6 and the lower substrate 3 may be temporarily fixed to each other after fixing the lower substrate 3 and the upper substrate 6 to each other by the suction of the suction mechanism 7 and returning the pressure of the vacuum container C to the atmospheric pressure.

[0031]

Also, in order to surely fix any one of the lower substrate 3 and the upper substrate 6, a mechanism for controlling the location of the substrate 3 or 6 may be further included.

[0032]

{Advantages}

According to the method for manufacturing the liquid crystal display device of the present invention, since the alignment is performed after bring the upper substrate into contact with the liquid crystal material or the adhesive, the state change due to the movement after the alignment is reduced and the moved distance is short. Thus, the positional deviation when sticking the lower substrate and the upper substrate can be removed and thus defect such as uneven image can be removed.

[0033]

Moreover, since both the substrates are approached to a prescribed interval location and the pre-alignment is performed, the positional deviation when sticking the lower substrate and the upper substrate can be removed and thus defect such as uneven image can be removed, and the movement amount of the lower substrate is reduced according to the pre-alignment when performing the alignment and thus the adhesive is more suppressed from being melted into the liquid crystal material.

[0034]

Also, since the upper substrate is held at a location having a micro-gap with the adhesive when bringing the upper substrate into contact with the liquid crystal material or the adhesive, the upper substrate and the lower substrate can be prevented from being tightly fixed to each other. Thus, a problem that the alignment can not be performed can be removed.

[0035]

Further, since the elastic body is interposed between the lower substrate and the suction mechanism, the gap between the upper substrate and the lower substrate can be obtained with high precision. Also, in this case, if the suction of the lower substrate is released after sticking the lower substrate and the upper substrate to each other, both the substrates are fixed by the suction mechanism of the upper substrate. Thus, the plane degree of both the substrates can be obtained with high precision.

[0036]

Moreover, since the suction of the lower substrate is released after the lower substrate and the upper substrate are stuck to each other, and the lower substrate and the upper substrate are temporarily fixed to each other by an ultraviolet ray curing type adhesive after the pressure of the vacuum container is returned to the atmospheric pressure,

the positional deviation of the upper substrate and the lower substrate can be surely prevented.

[0037]

Moreover, since the suction of the lower substrate is released and the pressure of the vacuum container is returned to the atmospheric pressure after the lower substrate and the upper substrate are stuck to each other and temporarily fixed to each other by an ultraviolet ray curing type adhesive, the positional deviation of the upper substrate and the lower substrate can be surely prevented.

[0038]

Also, since the location of at least one of the upper substrate and the lower substrate is controlled by the controlling mechanism, the upper substrate or the lower substrate can be surely fixed.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a schematic cross-sectional view of processes of a method for manufacturing a liquid crystal display device according to a first embodiment of the present invention.

[Fig. 2]

Fig. 2 is a schematic cross-sectional view of the following processes of Fig. 1.

[Fig. 3]

Fig. 3 is a schematic cross-sectional view of processes of a method for manufacturing a liquid crystal display device according to a second embodiment of the present invention.

[Fig. 4]

Fig. 4 is a schematic cross-sectional view of the following processes of Fig. 3.

[Fig. 5]

Fig. 5 is a cross-sectional view schematically showing the structure of a liquid crystal display device.

[Fig. 6]

Fig. 6 is a schematic cross-sectional view of processes of a liquid dropping method of a liquid crystal display device.

[Fig. 7]

Fig. 7 is a schematic cross-sectional view of processes of a conventional method for manufacturing a liquid crystal display device.

[Fig. 8]

Fig. 8 is a schematic cross-sectional view of the following processes of Fig. 7.

[Reference Numerals]

1: adhesive

2: liquid crystal material

3: lower substrate

5: suction mechanism  
6: upper substrate  
7: suction mechanism  
8: ultraviolet rays